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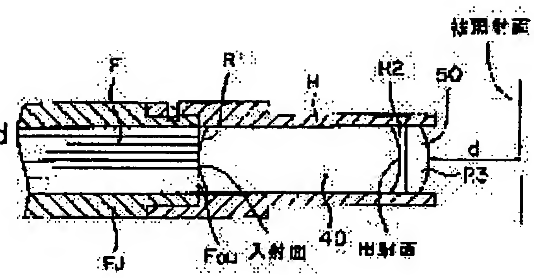
(54) LIGHTING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a lighting device capable of getting a lighting part close to a work and lighting the work at a high lighting illuminance without enlarging the diameter of the lighting part, and of efficient lighting without center drop of light on a lighted surface even if the lighting part and the work are far apart.

SOLUTION: This lighting device enters light from a discharge lamp into an incident end of a light guide F and concentrates light emitted from an emission end of the light guide F on a lighted surface by a projection optics system, and lights a work arranged on the lighted surface. The projection optics system is comprised of a rod lens 40 having spherical surfaces of the same radius of curvature on both ends, a plano-convex lens 50 or a both-side convex lens. Also, this projection optics system is constructed with the rod lens having spherical surface on both ends and a radius of curvature of the emission end spherical surface of the rod lens is kept smaller than the radius of curvature of the incident end spherical surface.



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CLAIMS

[Claim(s)]

[Claim 1] Condense the light emitted from the discharge lamp by the mirror, and incidence of the light which condensed is carried out to the incidence edge of the light guide arranged on the optical axis of a mirror. In the light irradiation device which irradiates the irradiated object which condensed the above-mentioned light which carries out outgoing radiation from the outgoing radiation edge of a light guide to the irradiated plane according to projection optics, and has been arranged at the irradiated plane said projection optics The light irradiation device characterized by having the spherical surface with the same radius of curvature to both ends, and consisting of a rod lens arranged by an incidence edge approaching the outgoing radiation edge of this light guide, and the planoconvex or the biconvex lens arranged by approaching the outgoing radiation edge of this rod lens.

[Claim 2] Condense the light emitted from the discharge lamp by the mirror, and incidence of the light which condensed is carried out to the incidence edge of the light guide arranged on the optical axis of a mirror. In the light irradiation device which irradiates the irradiated object which condensed the above-mentioned light which carries out outgoing radiation from the outgoing radiation edge of a light guide to the irradiated plane according to projection optics, and has been arranged at the irradiated plane said projection optics The light irradiation device characterized by the radius of curvature of the spherical surface of the outgoing radiation edge of this rod lens being smaller than the radius of curvature of the spherical surface of an incidence edge by the both ends where the incidence edge has been arranged by approaching the outgoing radiation edge of this light guide consisting of a rod lens of the spherical surface.

[Claim 3] The light irradiation device according to claim 1 or 2 characterized by irradiating said light at said irradiated object with which ultraviolet curing adhesives were applied.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the light irradiation device suitable for irradiating the light which includes ultraviolet rays to the field of the still narrower range about the light irradiation device which irradiates the irradiated object (work piece) which drew the light emitted from a discharge lamp by the light guide, and has been arranged at the irradiated plane, and performs optical processing, and performing ultraviolet treatment.
[0002]
[Description of the Prior Art] Irradiate the adhesives applied to the work piece, a coating, ink, a resist, etc., and they are made to harden the light by which outgoing radiation is carried out from a light irradiation device, or making it dry is performed. Moreover, conversely, melting of these is carried out or various processings of making it soften etc. are performed. And it is necessary to irradiate light in a minute region, and in adhesion of the pickup lens for optical disks by ultraviolet curing mold adhesives, and adhesion to the substrate of electronic parts etc., it leads by the light guide constituted [optical fibers / many] by bundling in the light of a discharge lamp, and it irradiates a minute region.
[0003] Drawing 1 shows an example of the internal configuration of the light irradiation device for irradiating a minute region. It is fixed to an attachment component 30, and the mirror 20 is being fixed to the attachment component 30 where a discharge lamp 10 is also inserted in the through tube 21 of a mirror 20. A discharge lamp 10 is a discharge lamp of short arc molds, such as a xenon lamp and an extra-high pressure mercury lamp, and opposite arrangement of cathode 11 and the anode plate 12 is carried out within luminescence. A cross-section configuration is an ellipse form and, as for a mirror 20, the luminescent spot of the light-emitting part between the cathode 11 of a discharge lamp 10 and an anode plate 12 is located in the 1st focus of a mirror 20. Usually, the luminescent spot of a light-emitting part is near a cathode tip. A light guide F is arranged on the optical axis L of a mirror 20, and the incidence edge Fin of a light guide F is located in the 2nd focus of a mirror 20. Moreover, Shutter St is arranged between the incidence edge Fin of a light guide F, and the discharge lamp 10, and if Shutter St is opened, incidence of the light condensed by the mirror 20 will be carried out to the incidence edge Fin of a light guide F. And the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F is irradiated by lens components, a substrate, etc. with which the work piece which performs optical exposure processing arranged to the optical exposure field in an irradiated plane, for example, ultraviolet curing mold adhesives, was applied.
[0004] In this light irradiation device, since the through tube 21 is formed in the central part of a mirror 20 as described above, only the light shown with the dotted-line slash in drawing 1 carries out incidence of the light which the reflected light does not exist in this part, but is reflected by the mirror 20 to the incidence edge Fin of a light guide F. That is, a big light of whenever [incident angle] carries out many incidence to the incidence edge Fin, and incidence of the small light near 0 degree which is whenever [incident angle] is hardly carried out to it.
[0005] The light which carried out incidence to the incidence edge Fin of a light guide F repeats reflection, where an include angle is held as a property of an optical fiber, and it transmits the

inside of a light guide F, and it carries out outgoing radiation from the outgoing radiation edge Fou at the same include angle as an incident angle. Since a big light of whenever [incident angle] carries out many incidence to a light guide F as described above, light with the big outgoing radiation include angle shown with the dotted-line slash in drawing 1 carries out many outgoing radiation of the light which carries out outgoing radiation from the outgoing radiation edge Fou. Here, if the distance d of the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is short, since the light near 0 degree with a small outgoing radiation include angle has the magnitude of [to some extent] phi5mm or phi3.5mm in the diameter of convergence of the optical fiber of a light guide F at least, the central illuminance of the illuminance distribution of an irradiated plane will be high, and it will become as low Yamagata as a periphery.

[0006] However, if the distance d of the outgoing radiation edge Fou of a light guide F and an irradiated plane becomes large, compared with a periphery, a center section will become low, and the phenomenon called "Extract inside" will produce the illuminance of the exposure field in an irradiated plane. Drawing 2 shows the relation of "extract inside" with the distance d of the outgoing radiation edge Fou of a light guide F, and an irradiated plane, when the diameter of convergence of an optical fiber is phi3.5mm, but if distance d is set to 20mm or more, the phenomenon "extracted inside" will become remarkable. And distance d of the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is set to 20mm or more in many cases from the relation of carrying in of the magnitude of a work piece, a configuration, and a work piece, and path clearance with a taking-out device etc.

[0007] In order to shorten the optical processing time, it is necessary to process with a high illuminance. However, if small work pieces, such as a pickup lens for optical disks, are arranged in the center of an exposure field when the distance of the outgoing radiation edge Fou and the irradiated plane by which a work piece is arranged is long, the illuminance of the light irradiated by the work piece for the phenomenon "extracted inside" will become low, and the processing time will become long. For this reason, a work piece is shifted from the center of an exposure field, and the illuminance is arranging and irradiating the periphery of a high exposure field. However, if the distance d of the time of carrying out optical processing of the work piece of a different class, and the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is changed, it is necessary to measure the illumination distribution of an irradiated plane each time, to ask for the location where an illuminance becomes the highest, and to set up suitably so that a work piece may come to the location. moreover — since the field where an illuminance is high is the periphery of an exposure field and the range is narrow — precision — good — a work-piece location — doubling — being crowded — stage picking — time and effort and time amount were required for changing.

[0008]

[Problem(s) to be Solved by the Invention] In order to cancel this phenomenon "extracted inside", it is possible to condense the light which carries out outgoing radiation from the outgoing radiation edge of a light guide to an irradiated plane in projection optics, and to irradiate the work piece arranged at the irradiated plane. In this case, since the illumination distribution of the outgoing radiation edge of a light guide is projected on an irradiated plane in projection optics, while being able to irradiate light efficiently to the field which needs an exposure in an irradiated plane, the phenomenon of illumination distribution "extracted inside" is cancelable.

[0009] Using the lens unit which combined two or more lenses as the above-mentioned projection optics for JP,64-75067,A is indicated. Drawing 3 shows an example of the lens unit LU which consists of the 1st lens L1 and the 2nd lens L2, the lens unit LU is attached in a light guide outgoing radiation edge, and the optical exposure section is constituted. In drawing 3 , the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F has fixed breadth according to the numerical aperture NA of the optical fiber which forms a light guide F. for example, the case of the optical fiber made from quartz glass — numerical-aperture NA= — it is about 0.22 and the angle of divergence in the air is equivalent to about 12.7 degrees.

[0010] Here, if the lenses L1 and L2 of the lens unit LU are brought close to the outgoing

radiation edge Fou of a light guide F, the scale factor projected on an irradiated plane by the lens unit LU will become large. That is, since the projected area in an irradiated plane becomes large, the illuminance of the whole exposure field becomes low. Therefore, in order to irradiate a narrow field with a high illuminance, only predetermined distance needs to separate the lenses L1 and L2 of the lens unit LU from the outgoing radiation edge Fou of a light guide F. And in order to use effectively the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F, most light which spread in about 12.7-degree above mentioned angle of divergence must be condensed with a lens, but for that purpose, as shown in drawing 3 , it is necessary to enlarge the diameter of a lens of the lens unit LU. For this reason, the diameter of a lens unit containing the holder H holding a lens becomes quite larger than the path of a light guide F, and the configuration of the optical outgoing radiation section is enlarged. In addition, since it is necessary to lengthen distance from the outgoing radiation edge Fou of a light guide F to a lens also when lengthening distance of a lens and an irradiated plane, as described above, a lens system becomes large and the configuration of the optical outgoing radiation section is enlarged.

[0011] Although the fixture for fixing a work piece may have enclosed the surroundings of it in actual optical exposure processing or it may be located in the inside where the part which irradiates light was surrounded by other components mounted in the substrate Anyway, if the configuration of the optical outgoing radiation section is large-sized, the optical outgoing radiation section cannot be made to be fully able to approach the part which irradiates the light of a work piece, and cannot be irradiated, but there is fault which cannot obtain desired irradiance.

[0012] Then, this invention aims at offering the light irradiation device [it is possible for the path of the optical outgoing radiation section not to be enlarged, to make the optical outgoing radiation section approach a work piece, and to carry out an optical exposure with high irradiance, and] which there is "no extract inside" even if the optical outgoing radiation section and a work piece are separated, and can carry out an optical exposure efficiently. [of the light irradiated by the irradiated plane]

[0013]

[Means for Solving the Problem] In order to attain this purpose, invention of claim 1 Condense the light emitted from the discharge lamp by the mirror, and incidence of the light which condensed is carried out to the incidence edge of the light guide arranged on the optical axis of a mirror. In the light irradiation device which irradiates the work piece which condensed the light which carries out outgoing radiation from the outgoing radiation edge of a light guide to the irradiated plane according to projection optics, and has been arranged at the irradiated plane It has the spherical surface with the same radius of curvature to both ends, and projection optics consists of a rod lens by which the incidence edge has been arranged by approaching the outgoing radiation edge of a light guide, and the planoconvex or the biconvex lens arranged by approaching the outgoing radiation edge of this rod lens. Moreover, the both ends where the incidence edge has been arranged by approaching the outgoing radiation edge of a light guide constitute this projection optics from a rod lens of the spherical surface, and invention of claim 2 makes the radius of curvature of the spherical surface of the outgoing radiation edge of a rod lens smaller than the radius of curvature of the spherical surface of an incidence edge. Furthermore, invention of claim 3 uses the light irradiation device equipped with the projection optics constituted as mentioned above, in order to harden ultraviolet curing mold adhesives.

[0014]

[Embodiment of the Invention] Below, based on a drawing, the gestalt of operation of this invention is explained concretely. Drawing 4 is the sectional view of the example of the optical outgoing radiation section of invention of claim 1. That is, the light source part of the light irradiation device of this invention is as being shown in drawing 1 , and has structure which the point of the light guide F of drawing 1 R> 1 shows to drawing 4 . In drawing 4 , it arranges and a light guide F bundles many optical fibers which consist of quartz glass so that the location in the incidence edge Fin of each optical fiber and the location in the outgoing radiation edge Fou may become random. The side face of the outgoing radiation edge Fou of this light guide F is covered

by the joint FJ which is tubed hardware, and the tubed electrode holder H is joined to Joint FJ. And in the electrode holder H, the rod lens 40 and plano-convex lens 50 made from quartz glass which work as projection optics are held. Here, it is somewhat large in whether the outer diameter of a rod lens 40 and a plano-convex lens 50 is almost equal to the diameter of convergence of an optical fiber. The example of the diameter of convergence of an optical fiber is phi3.5mm, and the outer diameter of Joint FJ is phi9mm. The outer diameter of a rod lens 40 and a plano-convex lens 50 is [whether it is the same as phi3.5mm, and] a little large extent. therefore -- without it makes the outer diameter of an electrode holder H larger than the outer diameter of Joint FJ -- projection optics -- **** -- since things are made, the outer diameter of the optical outgoing radiation section is not expanded.

[0015] The both ends of a rod lens 40 are the spherical surfaces, and another [the plane of incidence to which one edge carries out incidence of the light from a light guide F, and] edge is an outgoing radiation side which carries out outgoing radiation of the light which carried out incidence. The plane of incidence of a rod lens 40 is approached and prepared in the outgoing radiation edge Fou of a light guide F. That is, the plane of incidence of a rod lens 40 contacts the outgoing radiation edge Fou of a light guide F, or is held at intervals of [short] less than 1mm. Radius of curvature R1 of the plane of incidence of a rod lens 40 Radius of curvature R2 of an outgoing radiation side It is equal. moreover, the radius of curvature of a plano-convex lens 50 prepared in the outgoing radiation side side of a rod lens 40 -- R3 it is -- this radius of curvature R3 and the radius of curvature R1 (= R2) of a rod lens 40, and the optical-axis lay length of a rod lens 40 are designed according to the distance d to the irradiated plane which makes the light which carried out outgoing radiation of the plano-convex lens 50 condense. In addition, a plano-convex lens 50 may be a biconvex lens.

[0016] Although drawing 5 shows the example of the optical outgoing radiation section of invention of claim 2, in the electrode holder H, only the rod lens 40 with it is held. [an outer diameter almost equal to the diameter of convergence of an optical fiber or and] [somewhat larger] The both ends of a rod lens 40 are the radius of curvatures R2 of an outgoing radiation side, although it is the spherical surface like the case of the 1st example of the above. Radius of curvature R1 of plane of incidence By making it small, it can make it unnecessary to prepare a convex lens in the outgoing radiation side of a rod lens 40. And radius of curvature R1 And R2 The optical-axis lay length of a rod lens 40 is designed according to the distance d to the irradiated plane which makes the light which carried out outgoing radiation of the rod lens 40 condense.

[0017] Although a deer is carried out, incidence of the light condensed by the mirror 20 will be carried out to the incidence edge Fin of a light guide F and outgoing radiation will be carried out from the outgoing radiation edge Fou of a light guide F if the discharge lamp 10 shown in drawing 1 is turned on and Shutter St is opened As shown in drawing 6 in invention of claim 1, the light of the outgoing radiation edge Fou of a light guide F which carried out outgoing radiation from the optical fiber of a center section mostly If the maximum outgoing radiation include angle is made into 12.7 degrees (equivalent to about 0.22 of NA of a fiber), it will be refracted by the plane of incidence of a rod lens 40, and the outgoing radiation side of a rod lens 40 will be arrived at with breadth at the include angle of about 8.6 degrees. And outgoing radiation is carried out as a light almost parallel to an optical axis from the outgoing radiation side of a rod lens 40. On the other hand, since the plane of incidence of a rod lens 40 is a spherical-surface configuration, the light which carried out outgoing radiation from the optical fiber of the periphery of the outgoing radiation edge Fou of a light guide F is refracted in the direction of an optical axis of a light guide F, carries out incidence to a rod lens 40, and reaches the outgoing radiation side of a rod lens 40 with breadth at the include angle of about 8.6 degrees after that. And it laps with the light which carried out outgoing radiation from the center section of the light guide F in respect of the outgoing radiation of a rod lens 40, and outgoing radiation is carried out from the outgoing radiation side of a rod lens 40 at the include angle near 12.7 degrees to an optical axis. in addition -- a rod lens -- 40 -- inside -- an angle of divergence -- whenever -- theta -- ' (about 8.6 degrees) -- a rod lens -- 40 -- the quality of the material -- it is -- quartz glass -- a refractive index -- n -- ' (= 1.47) -- air -- a refractive index -- n (= 1) -- air -- inside -- an

angle of divergence — whenever — theta (12.7 degrees) — from — a Snell's law (nsintheta=n'sintheta') — being based — it can ask .

[0018] In order to use light most efficiently, as shown in drawing 6 , as for the light which carried out incidence to the rod lens 40, it is desirable to spread into the outgoing radiation flat-tapped cup of a rod lens 40 in the peripheral face of a rod lens 40. Then, since the quality of the material is quartz glass, and whenever [angle-of-divergence] is about 8.6 degrees when a path is phi3.5mm, the die length of a rod lens 40 is better than about 12mm or 12mm to make it a short jar a little.

[0019] The light which carried out incidence of the light which carried out outgoing radiation from the outgoing radiation side of a rod lens 40 to the plano-convex lens 50, and carried out outgoing radiation from the plano-convex lens 50 is the radius of curvature R3 of a plano-convex lens 50. It is based, and it is refracted and condenses to the optical exposure side of the set-up location. Here, the distance d from a plano-convex lens 50 to an irradiated plane is equivalent to the focal distance of a plano-convex lens 50. That is, a rod lens 40 and a plano-convex lens 50 commit the projection lens which projects the illumination distribution of the outgoing radiation edge Fou of a light guide F on an irradiated plane. Moreover, the illuminance distribution of the outgoing radiation edge Fou of a light guide F is equalized by the effectiveness of the random arrangement of an optical fiber. Therefore, by work of a rod lens 40, even if it lengthens distance d from the outgoing radiation section to an irradiated plane, "extract inside" does not arise in the illumination distribution of the exposure field in an irradiated plane.

[0020] Drawing 8 shows the irradiance distribution curve of the above-mentioned example which prepared the projection optics which consists of a rod lens 40 and a plano-convex lens 50 in the outgoing radiation edge Fou of a light guide F, and the conventional example shown in drawing 1 which does not prepare projection optics in the outgoing radiation edge Fou of a light guide F. Although the irradiance distribution curve in case the distance d from a plano-convex lens 50 thru/or the outgoing radiation edge Fou of a light guide F to an irradiated plane is 15mm and 20mm was searched for, the rod lens 40 and the plano-convex lens 50 were designed as the aforementioned distance of d= 15mm. Moreover, the diameter of convergence of an optical fiber is phi3.5mm.

[0021] The phenomenon "extract inside" in any [d= 15mm and d= 20mm] case was not accepted for this example so that drawing 8 might show. And since light was condensed by the irradiated plane which is d= 15mm, the illuminance of this example of an exposure field center section was much larger than the conventional example, and the sharp distribution curve was acquired. The illuminance of an exposure field center section being not only lower than this example but the phenomenon on the other hand, "be extracted inside" in the conventional example in the case of d= 20mm was seen.

[0022] Although drawing 7 shows one example of the optical-path Fig. of invention of claim 2 which does not use a plano-convex lens 50, it is the same as drawing 6 which shows the optical-path Fig. of invention of claim 1 until the light which carried out incidence to the rod lens 40 arrives at an outgoing radiation side. However, radius of curvature R2 of the outgoing radiation side of a rod lens 40 Radius of curvature R1 of plane of incidence Since it is small, light is refracted more greatly than the time of incidence, and outgoing radiation of it is carried out from a rod lens 40, and it condenses to the optical exposure side of the set-up location. That is, since a rod lens 40 commits the projection lens which projects the illumination distribution of the outgoing radiation edge Fou of a light guide F on an irradiated plane, it is and "extract inside" does not produce the same effectiveness as having used the plano-convex lens 50 in the illumination distribution of the exposure field in an irradiated plane. And since a plano-convex lens 50 is not used, components mark can be lessened, and since loss of the light by reflection or absorption decreases, an illuminance becomes high.

[0023]

[Effect of the Invention] As explained above, since this invention condenses the light which carries out outgoing radiation from a light guide to an irradiated plane according to the projection optics which consists of a rod lens or a rod lens, planoconvex, or a biconvex lens, also when the distance to an irradiated plane is large, the phenomenon "be extracted inside" to illumination

distribution does not occur, but it can make the irradiance of an exposure field center section high. Moreover, it is ****** to make the path of a rod lens and planoconvex, or a biconvex lens almost equivalent to the path of a light guide by replacing this air space with a rod lens with a large refractive index, although there were many rates that the air space between lenses occupies between a light guide and a lens and the diameter of a part lens was large conventionally. Therefore, in spite of having prepared projection optics in the outgoing radiation edge of a light guide, the path of the optical outgoing radiation section is not expanded. For this reason, also when the path clearance of the work piece which is an irradiated object, its carrying-in device, etc. is small, it becomes possible to make the optical outgoing radiation section approach a work piece. Moreover, even if the distance from the outgoing radiation section to a work piece becomes large, light without "extract inside" can be irradiated. Therefore, even if it can adjust exposure conditions easily and the quality of the material and the class of work piece change irrespective of the merits and demerits of the distance from an outgoing radiation edge to an irradiated plane, it can respond free to the exposure condition.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the light irradiation device suitable for irradiating the light which includes ultraviolet rays to the field of the still narrower range about the light irradiation device which irradiates the irradiated object (work piece) which drew the light emitted from a discharge lamp by the light guide, and has been arranged at the irradiated plane, and performs optical processing, and performing ultraviolet treatment.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] Irradiate the adhesives applied to the work piece, a coating, ink, a resist, etc., and they are made to harden the light by which outgoing radiation is carried out from a light irradiation device, or making it dry is performed. Moreover, conversely, melting of these is carried out or various processings of making it soften etc. are performed. And it is necessary to irradiate light in a minute region, and in adhesion of the pickup lens for optical disks by ultraviolet curing mold adhesives, and adhesion to the substrate of electronic parts etc., it leads by the light guide constituted [optical fibers / many] by bundling in the light of a discharge lamp, and it irradiates a minute region.
[0003] Drawing 1 shows an example of the internal configuration of the light irradiation device for irradiating a minute region. It is fixed to an attachment component 30, and the mirror 20 is being fixed to the attachment component 30 where a discharge lamp 10 is also inserted in the through tube 21 of a mirror 20. A discharge lamp 10 is a discharge lamp of short arc molds, such as a xenon lamp and an extra-high pressure mercury lamp, and opposite arrangement of cathode 11 and the anode plate 12 is carried out within luminescence. A cross-section configuration is an ellipse form and, as for a mirror 20, the luminescent spot of the light-emitting part between the cathode 11 of a discharge lamp 10 and an anode plate 12 is located in the 1st focus of a mirror 20. Usually, the luminescent spot of a light-emitting part is near a cathode tip. A light guide F is arranged on the optical axis L of a mirror 20, and the incidence edge Fin of a light guide F is located in the 2nd focus of a mirror 20. Moreover, Shutter St is arranged between the incidence edge Fin of a light guide F, and the discharge lamp 10, and if Shutter St is opened, incidence of the light condensed by the mirror 20 will be carried out to the incidence edge Fin of a light guide F. And the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F is irradiated by lens components, a substrate, etc. with which the work piece which performs optical exposure processing arranged to the optical exposure field in an irradiated plane, for example, ultraviolet curing mold adhesives, was applied.
[0004] In this light irradiation device, since the through tube 21 is formed in the central part of a mirror 20 as described above, only the light shown with the dotted-line slash in drawing 1 carries out incidence of the light which the reflected light does not exist in this part, but is reflected by the mirror 20 to the incidence edge Fin of a light guide F. That is, a big light of whenever [incident angle] carries out many incidence to the incidence edge Fin, and incidence of the small light near 0 degree which is whenever [incident angle] is hardly carried out to it.
[0005] The light which carried out incidence to the incidence edge Fin of a light guide F repeats reflection, where an include angle is held as a property of an optical fiber, and it transmits the inside of a light guide F, and it carries out outgoing radiation from the outgoing radiation edge Fou at the same include angle as an incident angle. Since a big light of whenever [incident angle] carries out many incidence to a light guide F as described above, light with the big outgoing radiation include angle shown with the dotted-line slash in drawing 1 carries out many outgoing radiation of the light which carries out outgoing radiation from the outgoing radiation edge Fou. Here, if the distance d of the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is short, since the light near 0 degree with a small outgoing radiation include angle has the magnitude of [to some extent] phi5mm or

phi3.5mm in the diameter of convergence of the optical fiber of a light guide F at least, the central illuminance of the illuminance distribution of an irradiated plane will be high, and it will become as low Yamagata as a periphery.

[0006] However, if the distance d of the outgoing radiation edge Fou of a light guide F and an irradiated plane becomes large, compared with a periphery, a center section will become low, and the phenomenon called "Extract inside" will produce the illuminance of the exposure field in an irradiated plane. Drawing 2 shows the relation of "extract inside" with the distance d of the outgoing radiation edge Fou of a light guide F, and an irradiated plane, when the diameter of convergence of an optical fiber is phi3.5mm, but if distance d is set to 20mm or more, the phenomenon "extracted inside" will become remarkable. And distance d of the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is set to 20mm or more in many cases from the relation of carrying in of the magnitude of a work piece, a configuration, and a work piece, and path clearance with a taking-out device etc.

[0007] In order to shorten the optical processing time, it is necessary to process with a high illuminance. However, if small work pieces, such as a pickup lens for optical disks, are arranged in the center of an exposure field when the distance of the outgoing radiation edge Fou and the irradiated plane by which a work piece is arranged is long, the illuminance of the light irradiated by the work piece for the phenomenon "extracted inside" will become low, and the processing time will become long. For this reason, a work piece is shifted from the center of an exposure field, and the illuminance is arranging and irradiating the periphery of a high exposure field. However, if the distance d of the time of carrying out optical processing of the work piece of a different class, and the outgoing radiation edge Fou of a light guide F and the irradiated plane by which a work piece is arranged is changed, it is necessary to measure the illumination distribution of an irradiated plane each time, to ask for the location where an illuminance becomes the highest, and to set up suitably so that a work piece may come to the location. moreover — since the field where an illuminance is high is the periphery of an exposure field and the range is narrow — precision — good — a work-piece location — doubling — being crowded — stage picking — time and effort and time amount were required for changing.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, since this invention condenses the light which carries out outgoing radiation from a light guide to an irradiated plane according to the projection optics which consists of a rod lens or a rod lens, planoconvex, or a biconvex lens, also when the distance to an irradiated plane is large, the phenomenon "be extracted inside" to illumination distribution does not occur, but it can make the irradiance of an exposure field center section high. Moreover, it is ****** to make the path of a rod lens and planoconvex, or a biconvex lens almost equivalent to the path of a light guide by replacing this air space with a rod lens with a large refractive index, although there were many rates that the air space between lenses occupies between a light guide and a lens and the diameter of a part lens was large conventionally. Therefore, in spite of having prepared projection optics in the outgoing radiation edge of a light guide, the path of the optical outgoing radiation section is not expanded. For this reason, also when the path clearance of the work piece which is an irradiated object, its carrying-in device, etc. is small, it becomes possible to make the optical outgoing radiation section approach a work piece. Moreover, even if the distance from the outgoing radiation section to a work piece becomes large, light without "extract inside" can be irradiated. Therefore, even if it can adjust exposure conditions easily and the quality of the material and the class of work piece change irrespective of the merits and demerits of the distance from an outgoing radiation edge to an irradiated plane, it can respond free to the exposure condition.

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* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In order to cancel this phenomenon "extracted inside", it is possible to condense the light which carries out outgoing radiation from the outgoing radiation edge of a light guide to an irradiated plane in projection optics, and to irradiate the work piece arranged at the irradiated plane. In this case, since the illumination distribution of the outgoing radiation edge of a light guide is projected on an irradiated plane in projection optics, while being able to irradiate light efficiently to the field which needs an exposure in an irradiated plane, the phenomenon of illumination distribution "extracted inside" is cancelable.
[0009] Using the lens unit which combined two or more lenses as the above-mentioned projection optics for JP,64-75067,A is indicated. Drawing 3 shows an example of the lens unit LU which consists of the 1st lens L1 and the 2nd lens L2, the lens unit LU is attached in a light guide outgoing radiation edge, and the optical exposure section is constituted. In drawing 3 , the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F has fixed breadth according to the numerical aperture NA of the optical fiber which forms a light guide F. for example, the case of the optical fiber made from quartz glass — numerical-aperture NA= — it is about 0.22 and the angle of divergence in the air is equivalent to about 12.7 degrees.

[0010] Here, if the lenses L1 and L2 of the lens unit LU are brought close to the outgoing radiation edge Fou of a light guide F, the scale factor projected on an irradiated plane by the lens unit LU will become large. That is, since the projected area in an irradiated plane becomes large, the illuminance of the whole exposure field becomes low. Therefore, in order to irradiate a narrow field with a high illuminance, only predetermined distance needs to separate the lenses L1 and L2 of the lens unit LU from the outgoing radiation edge Fou of a light guide F. And in order to use effectively the light which carried out outgoing radiation from the outgoing radiation edge Fou of a light guide F, most light which spread in about 12.7-degree above mentioned angle of divergence must be condensed with a lens, but for that purpose, as shown in drawing 3 , it is necessary to enlarge the diameter of a lens of the lens unit LU. For this reason, the diameter of a lens unit containing the holder H holding a lens becomes quite larger than the path of a light guide F, and the configuration of the optical outgoing radiation section is enlarged. In addition, since it is necessary to lengthen distance from the outgoing radiation edge Fou of a light guide F to a lens also when lengthening distance of a lens and an irradiated plane, as described above, a lens system becomes large and the configuration of the optical outgoing radiation section is enlarged.
[0011] Although the fixture for fixing a work piece may have enclosed the surroundings of it in actual optical exposure processing or it may be located in the inside where the part which irradiates light was surrounded by other components mounted in the substrate Anyway, if the configuration of the optical outgoing radiation section is large-sized, the optical outgoing radiation section cannot be made to be fully able to approach the part which irradiates the light of a work piece, and cannot be irradiated, but there is fault which cannot obtain desired irradiance.
[0012] Then, this invention aims at offering the light irradiation device [it is possible for the path of the optical outgoing radiation section not to be enlarged, to make the optical outgoing

radiation section approach a work piece, and to carry out an optical exposure with high irradiance, and] which there is "no extract inside" even if the optical outgoing radiation section and a work piece are separated, and can carry out an optical exposure efficiently. [of the light irradiated by the irradiated plane]

[Translation done.]

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MEANS

[Means for Solving the Problem] In order to attain this purpose, invention of claim 1 Condense the light emitted from the discharge lamp by the mirror, and incidence of the light which condensed is carried out to the incidence edge of the light guide arranged on the optical axis of a mirror. In the light irradiation device which irradiates the work piece which condensed the light which carries out outgoing radiation from the outgoing radiation edge of a light guide to the irradiated plane according to projection optics, and has been arranged at the irradiated plane It has the spherical surface with the same radius of curvature to both ends, and projection optics consists of a rod lens by which the incidence edge has been arranged by approaching the outgoing radiation edge of a light guide, and the planoconvex or the biconvex lens arranged by approaching the outgoing radiation edge of this rod lens. Moreover, the both ends where the incidence edge has been arranged by approaching the outgoing radiation edge of a light guide constitute this projection optics from a rod lens of the spherical surface, and invention of claim 2 makes the radius of curvature of the spherical surface of the outgoing radiation edge of a rod lens smaller than the radius of curvature of the spherical surface of an incidence edge. Furthermore, invention of claim 3 uses the light irradiation device equipped with the projection optics constituted as mentioned above, in order to harden ultraviolet curing mold adhesives.
[0014]
[Embodiment of the Invention] Below, based on a drawing, the gestalt of operation of this invention is explained concretely. Drawing 4 is the sectional view of the example of the optical outgoing radiation section of invention of claim 1. That is, the light source part of the light irradiation device of this invention is as being shown in drawing 1 , and has structure which the point of the light guide F of drawing 1 R> 1 shows to drawing 4 . In drawing 4 , it arranges and a light guide F bundles many optical fibers which consist of quartz glass so that the location in the incidence edge Fin of each optical fiber and the location in the outgoing radiation edge Fou may become random. The side face of the outgoing radiation edge Fou of this light guide F is covered by the joint FJ which is tubed hardware, and the tubed electrode holder H is joined to Joint FJ. And in the electrode holder H, the rod lens 40 and plano-convex lens 50 made from quartz glass which work as projection optics are held. Here, it is somewhat large in whether the outer diameter of a rod lens 40 and a plano-convex lens 50 is almost equal to the diameter of convergence of an optical fiber. The example of the diameter of convergence of an optical fiber is phi3.5mm, and the outer diameter of Joint FJ is phi9mm. The outer diameter of a rod lens 40 and a plano-convex lens 50 is [whether it is the same as phi3.5mm, and] a little large extent. therefore — without it makes the outer diameter of an electrode holder H larger than the outer diameter of Joint FJ — projection optics — **** — since things are made, the outer diameter of the optical outgoing radiation section is not expanded.
[0015] The both ends of a rod lens 40 are the spherical surfaces, and another [the plane of incidence to which one edge carries out incidence of the light from a light guide F, and] edge is an outgoing radiation side which carries out outgoing radiation of the light which carried out incidence. The plane of incidence of a rod lens 40 is approached and prepared in the outgoing radiation edge Fou of a light guide F. That is, the plane of incidence of a rod lens 40 contacts the outgoing radiation edge Fou of a light guide F, or is held at intervals of [short] less than 1mm.

Radius of curvature R1 of the plane of incidence of a rod lens 40 Radius of curvature R2 of an outgoing radiation side It is equal. moreover, the radius of curvature of a plano-convex lens 50 prepared in the outgoing radiation side side of a rod lens 40 — R3 it is — this radius of curvature R3 and the radius of curvature R1 (= R2) of a rod lens 40, and the optical-axis lay length of a rod lens 40 are designed according to the distance d to the irradiated plane which makes the light which carried out outgoing radiation of the plano-convex lens 50 condense. In addition, a plano-convex lens 50 may be a biconvex lens.

[0016] Although drawing 5 shows the example of the optical outgoing radiation section of invention of claim 2, in the electrode holder H, only the rod lens 40 with it is held. [an outer diameter almost equal to the diameter of convergence of an optical fiber or and] [somewhat larger] The both ends of a rod lens 40 are the radius of curvatures R2 of an outgoing radiation side, although it is the spherical surface like the case of the 1st example of the above. Radius of curvature R1 of plane of incidence By making it small, it can make it unnecessary to prepare a convex lens in the outgoing radiation side of a rod lens 40. And radius of curvature R1 And R2 The optical-axis lay length of a rod lens 40 is designed according to the distance d to the irradiated plane which makes the light which carried out outgoing radiation of the rod lens 40 condense.

[0017] Although a deer is carried out, incidence of the light condensed by the mirror 20 will be carried out to the incidence edge Fin of a light guide F and outgoing radiation will be carried out from the outgoing radiation edge Fou of a light guide F if the discharge lamp 10 shown in drawing 1 is turned on and Shutter St is opened As shown in drawing 6 in invention of claim 1, the light of the outgoing radiation edge Fou of a light guide F which carried out outgoing radiation from the optical fiber of a center section mostly If the maximum outgoing radiation include angle is made into 12.7 degrees (equivalent to about 0.22 of NA of a fiber), it will be refracted by the plane of incidence of a rod lens 40, and the outgoing radiation side of a rod lens 40 will be arrived at with breadth at the include angle of about 8.6 degrees. And outgoing radiation is carried out as a light almost parallel to an optical axis from the outgoing radiation side of a rod lens 40. On the other hand, since the plane of incidence of a rod lens 40 is a spherical-surface configuration, the light which carried out outgoing radiation from the optical fiber of the periphery of the outgoing radiation edge Fou of a light guide F is refracted in the direction of an optical axis of a light guide F, carries out incidence to a rod lens 40, and reaches the outgoing radiation side of a rod lens 40 with breadth at the include angle of about 8.6 degrees after that. And it laps with the light which carried out outgoing radiation from the center section of the light guide F in respect of the outgoing radiation of a rod lens 40, and outgoing radiation is carried out from the outgoing radiation side of a rod lens 40 at the include angle near 12.7 degrees to an optical axis. in addition — a rod lens — 40 — inside — an angle of divergence — whenever — theta — ' (about 8.6 degrees) — a rod lens — 40 — the quality of the material — it is — quartz glass — a refractive index — n — ' (= 1.47) — air — a refractive index — n (= 1) — air — inside — an angle of divergence — whenever — theta (12.7 degrees) — from — a Snell's law (nsintheta=n'sintheta') — being based — it can ask .

[0018] In order to use light most efficiently, as shown in drawing 6 , as for the light which carried out incidence to the rod lens 40, it is desirable to spread into the outgoing radiation flat-tapped cup of a rod lens 40 in the peripheral face of a rod lens 40. Then, since the quality of the material is quartz glass, and whenever [angle-of-divergence] is about 8.6 degrees when a path is phi3.5mm, the die length of a rod lens 40 is better than about 12mm or 12mm to make it a short jar a little.

[0019] The light which carried out incidence of the light which carried out outgoing radiation from the outgoing radiation side of a rod lens 40 to the plano-convex lens 50, and carried out outgoing radiation from the plano-convex lens 50 is the radius of curvature R3 of a plano-convex lens 50. It is based, and it is refracted and condenses to the optical exposure side of the set-up location. Here, the distance d from a plano-convex lens 50 to an irradiated plane is equivalent to the focal distance of a plano-convex lens 50. That is, a rod lens 40 and a plano-convex lens 50 commit the projection lens which projects the illumination distribution of the outgoing radiation edge Fou of a light guide F on an irradiated plane. Moreover, the illuminance distribution of the outgoing

radiation edge Fou of a light guide F is equalized by the effectiveness of the random arrangement of an optical fiber. Therefore, by work of a rod lens 40, even if it lengthens distance d from the outgoing radiation section to an irradiated plane, "extract inside" does not arise in the illumination distribution of the exposure field in an irradiated plane.

[0020] Drawing 8 shows the irradiance distribution curve of the above-mentioned example which prepared the projection optics which consists of a rod lens 40 and a plano-convex lens 50 in the outgoing radiation edge Fou of a light guide F, and the conventional example shown in drawing 1 which does not prepare projection optics in the outgoing radiation edge Fou of a light guide F. Although the irradiance distribution curve in case the distance d from a plano-convex lens 50 thru/or the outgoing radiation edge Fou of a light guide F to an irradiated plane is 15mm and 20mm was searched for, the rod lens 40 and the plano-convex lens 50 were designed as the aforementioned distance of d= 15mm. Moreover, the diameter of convergence of an optical fiber is phi3.5mm.

[0021] The phenomenon "extract inside" in any [d= 15mm and d= 20mm] case was not accepted for this example so that drawing 8 might show. And since light was condensed by the irradiated plane which is d= 15mm, the illuminance of this example of an exposure field center section was much larger than the conventional example, and the sharp distribution curve was acquired. The illuminance of an exposure field center section being not only lower than this example but the phenomenon on the other hand, "be extracted inside" in the conventional example in the case of d= 20mm was seen.

[0022] Although drawing 7 shows one example of the optical-path Fig. of invention of claim 2 which does not use a plano-convex lens 50, it is the same as drawing 6 which shows the optical-path Fig. of invention of claim 1 until the light which carried out incidence to the rod lens 40 arrives at an outgoing radiation side. However, radius of curvature R2 of the outgoing radiation side of a rod lens 40 Radius of curvature R1 of plane of incidence Since it is small, light is refracted more greatly than the time of incidence, and outgoing radiation of it is carried out from a rod lens 40, and it condenses to the optical exposure side of the set-up location. That is, since a rod lens 40 commits the projection lens which projects the illumination distribution of the outgoing radiation edge Fou of a light guide F on an irradiated plane, it is and "extract inside" does not produce the same effectiveness as having used the plano-convex lens 50 in the illumination distribution of the exposure field in an irradiated plane. And since a plano-convex lens 50 is not used, components mark can be lessened, and since loss of the light by reflection or absorption decreases, an illuminance becomes high.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view of a light irradiation device.
[Drawing 2] It is the explanatory view of "extract inside" of illumination distribution.
[Drawing 3] It is the explanatory view of the conventional example of the optical outgoing radiation section.
[Drawing 4] It is the sectional view of the optical outgoing radiation section of invention of claim 1.
[Drawing 5] It is the sectional view of the optical outgoing radiation section of invention of claim 2.
[Drawing 6] It is the optical-path Fig. of invention of claim 1.
[Drawing 7] It is the optical-path Fig. of invention of claim 2.
[Drawing 8] It is an irradiance distribution curve Fig.
[Description of Notations]
10 Discharge Lamp
11 Cathode
12 Anode Plate
20 Mirror
30 Attachment Component
40 Rod Lens
50 Plano-convex Lens
F Light guide
Fin Incidence edge of a light guide
Fou Outgoing radiation edge of a light guide
FJ Joint
H Electrode holder
St Shutter

[Translation done.]

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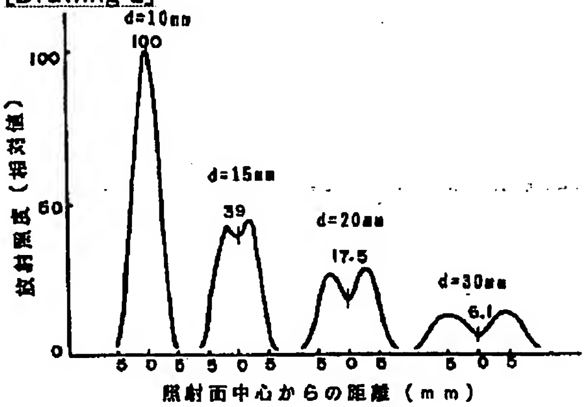
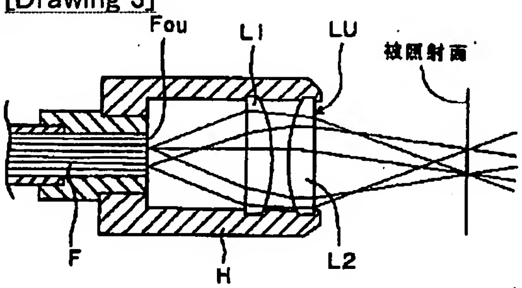
DRAWINGS

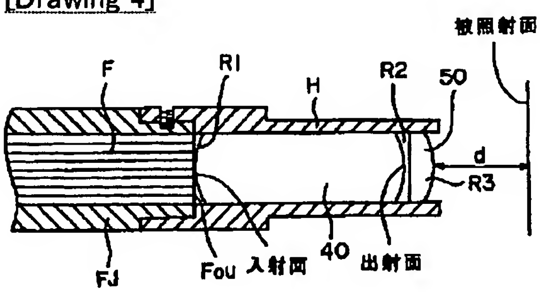
[Drawing 2]



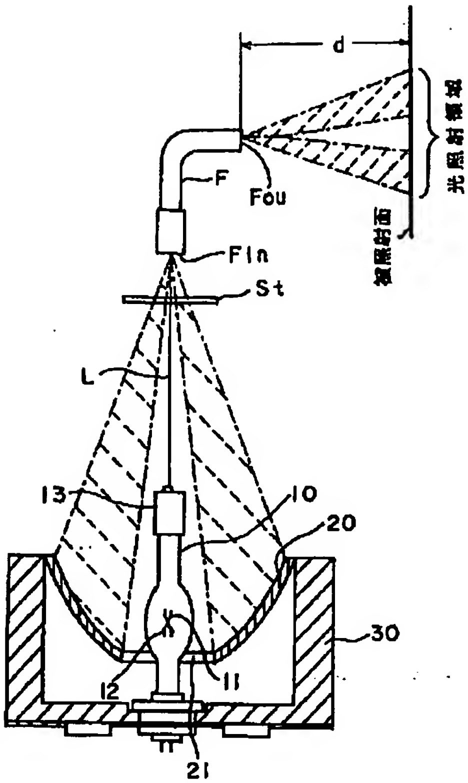
[Drawing 3]



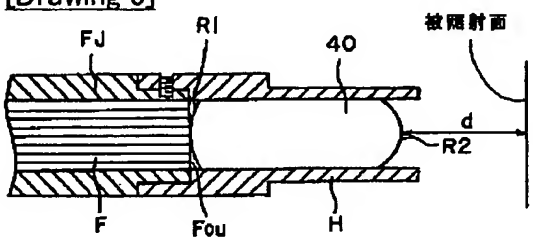
[Drawing 4]



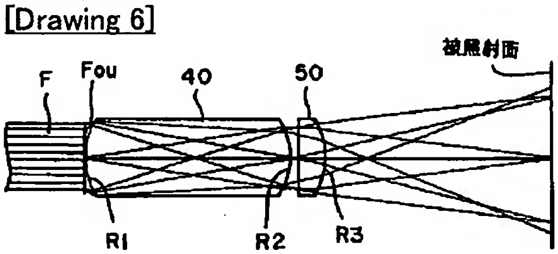
[Drawing 1]



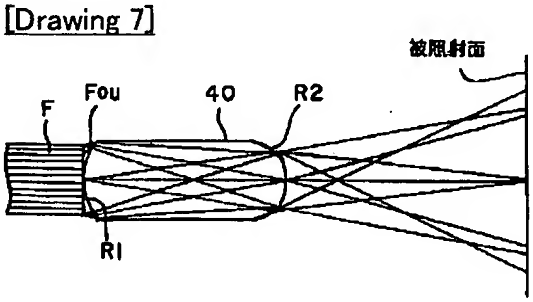
[Drawing 5]



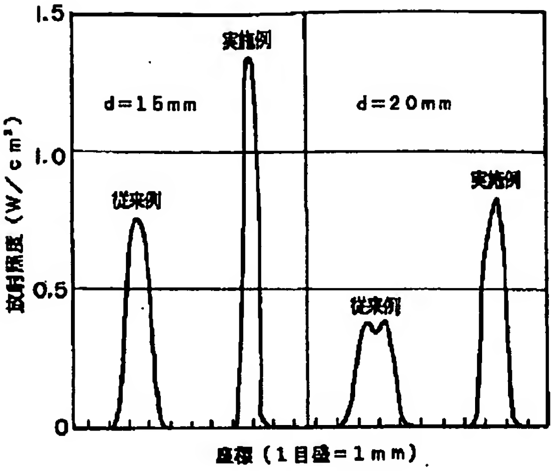
[Drawing 6]



[Drawing 7]



[Drawing 8]



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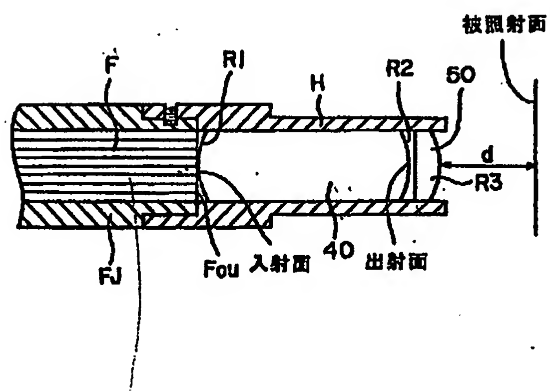
(54)【発明の名称】　光照射装置

(57)【要約】
【課題】光出射部の径が大型化することがなく、光出射部をワークに接近させて高い放射照度で光照射することが可能であり、また、光出射部とワークとが離れていても、被照射面に照射される光の「中抜け」がなく、効率よく光照射することが可能な光照射装置を提供する。
【解決手段】放電ランプの光をライトガイドFの入射端に入射し、ライトガイドの出射端から出射する光を投影光学系により被照射面に集光し、被照射面に配置されたワークに照射する光照射装置において、投影光学系を、両端に曲率半径が同じ球面を有するロッドレンズ40と平凸50または両凸レンズとで構成する。また、この投影光学系を、両端が球面のロッドレンズで構成し、ロッドレンズの出射端の球面の曲率半径を入射端の球面の曲率半径よりも小さくする。



【特許請求の範囲】

【請求項１】　放電ランプから放射された光をミラーで集光し、集光した光を、ミラーの光軸上に配置したライトガイドの入射端に入射し、ライトガイドの出射端から出射する上記光を投影光学系により被照射面に集光し、被照射面に配置された被照射物に照射する光照射装置において、

前記投影光学系は、両端に曲率半径が同じ球面を有し、入射端が該ライトガイドの出射端に近接して配置されたロッドレンズと、該ロッドレンズの出射端に近接して配置された平凸または両凸レンズからなることを特徴とする光照射装置。

【請求項２】　放電ランプから放射された光をミラーで集光し、集光した光を、ミラーの光軸上に配置したライトガイドの入射端に入射し、ライトガイドの出射端から出射する上記光を投影光学系により被照射面に集光し、被照射面に配置された被照射物に照射する光照射装置において、

前記投影光学系は、入射端が該ライトガイドの出射端に近接して配置された、両端が球面のロッドレンズからなり、該ロッドレンズの出射端の球面の曲率半径が入射端の球面の曲率半径よりも小さいことを特徴とする光照射装置。

【請求項３】　紫外線硬化接着剤が塗布された前記被照射物に前記光を照射することを特徴とする請求項１又は請求項２記載の光照射装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、放電ランプから放射される光をライトガイドで導いて被照射面に配置された被照射物（ワーク）に照射して光処理を行う光照射装置に関し、更には狭い範囲の領域に紫外線を含む光を照射して紫外線処理を行うのに適した光照射装置に関するものである。

【０００２】

【従来の技術】光照射装置から出射される光をワークに塗布した接着剤、塗料、インキ、レジストなどに照射して硬化させたり乾燥させることが行われる。また、逆に、これらを溶融させたり軟化させるなどのさまざまな処理が行われる。そして、紫外線硬化型接着剤による光ディスク用のピックアップレンズの接着や、電子部品の基板への接着の場合などは、微小域に光を照射する必要があり、放電ランプの光を光ファイバーを多数束ねて構成されるライトガイドで導いて微小域に照射する。

【０００３】図１は、微小域に照射するための光照射装置の内部構成の一例を示す。ミラー２０が保持部材３０に固定され、放電ランプ１０もミラー２０の貫通孔２１に挿通された状態で保持部材３０に固定されている。放電ランプ１０は、例えばキセノンランプや超高圧水銀ランプなどのショートアーク型の放電ランプであり、発光管内に陰極１１と陽極１２が対向配置されている。ミラー２０は、断面形状が楕円形であり、放電ランプ１０の陰極１１と陽極１２の間の発光部の輝点がミラー２０の第１焦点に位置している。通常、発光部の輝点は陰極先端付近にある。ミラー２０の光軸Ｌ上にライトガイドＦが配置され、ライトガイドＦの入射端Ｆｉｎがミラー２０の第２焦点に位置している。また、ライトガイドＦの入射端Ｆｉｎと放電ランプ１０との間にはシャッターＳｔが配置されており、シャッターＳｔを開くと、ミラー２０で集光された光はライトガイドＦの入射端Ｆｉｎに入射する。そして、ライトガイドＦの出射端Ｆｏｕから出射した光は被照射面における光照射領域に配置された光照射処理を行うワーク、例えば紫外線硬化型接着剤が塗布されたレンズ部品や基板などに照射される。

【０００４】かかる光照射装置において、上記したようにミラー２０の中央部分には貫通孔２１が形成されているので、この部分には反射光が存在せず、ミラー２０で反射する光は、図１において点線斜線で示した光のみがライトガイドＦの入射端Ｆｉｎに入射する。つまり、入射端Ｆｉｎには、入射角度の大きな光が多く入射し、入射角度の小さな０゜に近い光はほとんど入射しない。

【０００５】ライトガイドＦの入射端Ｆｉｎに入射した光は、光ファイバーの性質として角度が保持された状態で反射を繰り返してライトガイドＦ内を伝送し、入射角と同じ角度で出射端Ｆｏｕから出射する。上記したようにライトガイドＦには、入射角度の大きな光が多く入射するので、出射端Ｆｏｕから出射する光は、図１において点線斜線で示した出射角度の大きな光が多く出射する。ここで、ライトガイドＦの出射端Ｆｏｕとワークが配置される被照射面との距離ｄが短いと、被照射面の照度分布は、出射角度の小さな０゜に近い光が少なくても、ライトガイドＦの光ファイバの収束径がある程度、例えばφ５ｍｍやφ３．５ｍｍという大きさを有するため、中央の照度が高く、周辺部ほど低い山形になる。

【０００６】しかし、ライトガイドＦの出射端Ｆｏｕと被照射面との距離ｄが大きくなると、被照射面における照射領域の照度は周辺部に比べて中央部が低くなり、「中抜け」と称する現象が生じる。図２は、光ファイバの収束径がφ３．５ｍｍの場合に、ライトガイドＦの出射端Ｆｏｕと被照射面との距離ｄと「中抜け」の関係を示すが、距離ｄが２０ｍｍ以上になると「中抜け」現象が顕著になる。そして、ワークの大きさや形状、ワークの搬入、搬出機構とのクリアランスの関係などから、ライトガイドＦの出射端Ｆｏｕとワークが配置される被照射面との距離ｄを２０ｍｍ以上にする場合が多い。

【０００７】光処理時間を短くするためには、高い照度で処理する必要がある。しかし、出射端Ｆｏｕとワークが配置される被照射面との距離が長い場合に、光ディスク用のピックアップレンズなどの小さなワークを照射領域の中央に配置すると、「中抜け」現象のためにワーク

に照射される光の照度が低くなり、処理時間が長くなる。このため、ワークを照射領域の中央からずらして、照度が高い照射領域の周辺部に配置して照射している。しかし、異なる種類のワークを光処理するときや、ライトガイドFの出射端Ｆｏｕとワークが配置される被照射面との距離ｄが変更されると、その都度被照射面の照度分布を測定して、照度が最も高くなる場所を求め、ワークがその位置に来るように適宜設定する必要がある。また、照度の高い領域は照射領域の周辺部であり、その範囲は狭いので、精度良くワーク位置を合わせ込む必要があり、段取り変えに手間と時間を要していた。

【０００８】

【発明が解決しようとする課題】この「中抜け」現象を解消するために、ライトガイドの出射端から出射する光を投影光学系にて被照射面に集光して、被照射面に配置されたワークに照射することが考えられる。この場合、ライトガイドの出射端の照度分布を投影光学系にて被照射面に投影するので、被照射面において照射を必要とする領域に対して、効率よく光を照射できるとともに、照度分布の「中抜け」現象を解消することができる。

【０００９】特開昭６４－７５０６７号公報には、上記投影光学系として複数のレンズを組み合わせたレンズユニットを使用することが開示されている。図３は、第１レンズＬ１と第２レンズＬ２からなるレンズユニットＬＵの一例を示し、ライトガイド出射端にレンズユニットＬＵが取り付けられ、光出射部が構成されている。図３において、ライトガイドＦの出射端Ｆｏｕから出射した光は、ライトガイドＦを形成する光ファイバーの開口数ＮＡに従って一定の広がりを持つ。例えば石英ガラス製の光ファイバーの場合、開口数ＮＡ＝約０．２２であり、その空気中の広がり角は約１２．７゜に相当する。

【００１０】ここで、レンズユニットＬＵのレンズＬ１，Ｌ２をライトガイドＦの出射端Ｆｏｕに近づけると、レンズユニットＬＵによって被照射面に投影される倍率が大きくなる。つまり被照射面における投影面積が大きくなるので、照射領域全体の照度は低くなる。従って、狭い領域に高い照度で照射するためには、レンズユニットＬＵのレンズＬ１，Ｌ２をライトガイドＦの出射端Ｆｏｕから所定距離だけ離す必要がある。そして、ライトガイドＦの出射端Ｆｏｕから出射した光を有効に利用するために、前記した約１２．７゜の広がり角で広がった光のほとんどをレンズにより集光しなければならないが、そのためには、図３に示すように、レンズユニットＬＵのレンズ径を大きくする必要がある。このため、レンズを保持するホルダHを含むレンズユニット径がライトガイドＦの径よりもかなり大きくなり、光出射部の形状が大型化する。なお、レンズと被照射面との距離を長くする場合にも、ライトガイドＦの出射端Ｆｏｕからレンズまでの距離を長くする必要があるので、上記したように、レンズ系は大きくなり、光出射部の形状は大型化する。

【００１１】実際の光照射処理においては、ワークを固定するための治具がその周りを囲っていたり、光を照射する部分が基板に実装された他の部品に囲まれた中に位置する場合などがあるが、いずれにしても、光出射部の形状が大型であれば、光出射部をワークの光を照射する部分に十分に接近させて照射することができず、所望の放射照度を得られない不具合がある。

【００１２】そこで本発明は、光出射部の径が大型化することがなく、光出射部をワークに接近させて高い放射照度で光照射することが可能であり、また、光出射部とワークとが離れていても、被照射面に照射される光の「中抜け」がなく、効率よく光照射することが可能な光照射装置を提供することを目的とする。

【００１３】

【課題を解決するための手段】かかる目的を達成するために、請求項１の発明は、放電ランプから放射された光をミラーで集光し、集光した光を、ミラーの光軸上に配置したライトガイドの入射端に入射し、ライトガイドの出射端から出射する光を投影光学系により被照射面に集光し、被照射面に配置されたワークに照射する光照射装置において、投影光学系を、両端に曲率半径が同じ球面を有し、入射端がライトガイドの出射端に近接して配置されたロッドレンズと、このロッドレンズの出射端に近接して配置された平凸または両凸レンズとで構成する。また、請求項２の発明は、この投影光学系を、入射端がライトガイドの出射端に近接して配置された、両端が球面のロッドレンズで構成し、ロッドレンズの出射端の球面の曲率半径を入射端の球面の曲率半径よりも小さくする。更には請求項３の発明は、紫外線硬化型接着剤を硬化するために、上記のように構成した投影光学系を備えた光照射装置を用いる。

【００１４】

【発明の実施の形態】以下に、図面に基づいて本発明の実施の形態を具体的に説明する。図４は、請求項１の発明の光出射部の実施例の断面図である。つまり、本発明の光照射装置の光源部分は図１に示すとおりであり、図１のライトガイドＦの先端部が図４に示す構造になっている。図４において、ライトガイドＦは、石英ガラスからなる多数の光ファイバーを、個々の光ファイバーの入射端Ｆｉｎにおける位置と出射端Ｆｏｕにおける位置がランダムになるように配列して束ねたものである。このライトガイドＦの出射端Ｆｏｕの側面は筒状の金物である接合部ＦＪで覆われており、接合部ＦＪに筒状のホルダーHが接合されている。そして、ホルダーH内には、投影光学系として働く石英ガラス製のロッドレンズ４０および平凸レンズ５０が保持されている。ここで、ロッドレンズ４０および平凸レンズ５０の外径は光ファイバーの収束径にほぼ等しいか、少し大きめである。光ファイバーの収束径の具体例は、例えばφ３．５ｍｍであ

り、接合部ＦＪの外径はφ９ｍｍである。ロッドレンズ４０および平凸レンズ５０の外径は、φ３．５ｍｍと同じか、幾分大きい程度である。従って、ホルダーＨの外径を接合部ＦＪの外径よりも大きくすることなく、投影光学系を設ることができるので、光出射部の外径は拡大しない。

【００１５】ロッドレンズ４０の両端は球面であり、一方の端はライトガイドＦからの光を入射する入射面、もう一方の端は入射した光を出射する出射面である。ロッドレンズ４０の入射面をライトガイドＦの出射端Ｆｏｕに近接して設ける。つまり、ロッドレンズ４０の入射面はライトガイドＦの出射端Ｆｏｕに接触するか、もしくは１ｍｍ以内の短い間隔で保持されている。ロッドレンズ４０の入射面の曲率半径R_1と出射面の曲率半径R_2とは等しくなっている。また、ロッドレンズ４０の出射面側に設けられた平凸レンズ５０の曲率半径はR_3であり、この曲率半径R_3、およびロッドレンズ４０の曲率半径R_1（＝R_2）とロッドレンズ４０の光軸方向の長さは、平凸レンズ５０を出射した光を集光させる被照射面までの距離ｄに応じて設計される。なお、平凸レンズ５０は両凸レンズであってもよい。

【００１６】図５は請求項２の発明の光出射部の実施例を示すが、ホルダーＨ内には、外径が光ファイバーの収束径にほぼ等しいか、少し大きめのロッドレンズ４０のみが保持されている。ロッドレンズ４０の両端は上記第１の実施例の場合と同様に球面であるが、出射面の曲率半径R_2を入射面の曲率半径R_1よりも小さくすることにより、ロッドレンズ４０の出射側に凸レンズを設けることを不要とすることができる。そして、曲率半径R_1およびR_2とロッドレンズ４０の光軸方向の長さは、ロッドレンズ４０を出射した光を集光させる被照射面までの距離ｄに応じて設計される。

【００１７】しかして、図１に示す放電ランプ１０を点灯し、シャッターＳｔを開くと、ミラー２０で集光された光はライトガイドＦの入射端Ｆｉｎに入射し、ライトガイドＦの出射端Ｆｏｕから出射するが、請求項１の発明の場合は、図６に示すように、ライトガイドＦの出射端Ｆｏｕのほぼ中央部の光ファイバーから出射した光は、最大出射角度を１２．７°（ファイバーのＮＡの約０．２２に相当）とすると、ロッドレンズ４０の入射面で屈折し、約８．６°の角度で広がりながらロッドレンズ４０の出射面に達する。そして、ロッドレンズ４０の出射面から光軸にほぼ平行な光として出射する。一方、ライトガイドＦの出射端Ｆｏｕの周辺部の光ファイバーから出射した光は、ロッドレンズ４０の入射面が球面形状であるので、ライトガイドＦの光軸方向に屈折してロッドレンズ４０に入射し、その後は、約８．６°の角度で広がりながら、ロッドレンズ４０の出射面に達する。そして、ロッドレンズ４０の出射面でライトガイドＦの中央部から出射した光と重なり、光軸に対して１２．７°に近い角度でロッドレンズ４０の出射面から出射する。なお、ロッドレンズ４０中での広がり角度θ'（約８．６°）は、ロッドレンズ４０の材質である石英ガラスの屈折率n'（＝１．４７）、空気の屈折率ｎ（＝１）、空気中での広がり角度θ（１２．７°）から、スネルの法則（$n\sin\theta = n'\sin\theta'$）に基づいて求めることができる。

【００１８】光を最も効率よく利用するためには、ロッドレンズ４０に入射した光は、図６に示すように、ロッドレンズ４０の外周面に当たることなく、ロッドレンズ４０の出射面一杯に広がることが望ましい。そこで、ロッドレンズ４０の長さは、材質が石英ガラスであり、径がφ３．５ｍｍの場合、広がり角度が約８．６°であるので、約１２ｍｍまたは１２ｍｍよりやや短かめにするのがよい。

【００１９】ロッドレンズ４０の出射面から出射した光は、平凸レンズ５０に入射し、平凸レンズ５０から出射した光は、平凸レンズ５０の曲率半径R_3に基づいて屈折し、設定された位置の光照射面に集光する。ここで、平凸レンズ５０から被照射面までの距離ｄは平凸レンズ５０の焦点距離に相当する。すなわち、ロッドレンズ４０と平凸レンズ５０が、ライトガイドＦの出射端Ｆｏｕの照度分布を被照射面に投影する投影レンズの働きをする。また、ライトガイドＦの出射端Ｆｏｕの照度分布は、光ファイバーのランダム配列の効果により均一化されている。従って、ロッドレンズ４０の働きにより、出射部から被照射面までの距離ｄを長くしても被照射面における照射領域の照度分布に「中抜け」が生じない。

【００２０】図８は、ライトガイドＦの出射端Ｆｏｕにロッドレンズ４０および平凸レンズ５０からなる投影光学系を設けた前述の実施例、およびライトガイドＦの出射端Ｆｏｕに投影光学系を設けない図１に示す従来例の放射照度分布曲線を示す。平凸レンズ５０ないしライトガイドＦの出射端Ｆｏｕから被照射面までの距離ｄが１５ｍｍおよび２０ｍｍの場合の放射照度分布曲線を求めたが、ロッドレンズ４０および平凸レンズ５０は、前記の距離ｄ＝１５ｍｍとして設計した。また、光ファイバーの収束径はφ３．５ｍｍである。

【００２１】図８から分かるように、本実施例は、ｄ＝１５ｍｍおよびｄ＝２０ｍｍのいずれの場合も「中抜け」現象は認められなかった。そして、本実施例は、光がｄ＝１５ｍｍの被照射面に集光されるので、照射領域中央部の照度が従来例よりもずっと大きく、シャープな分布曲線が得られた。一方、従来例では、照射領域中央部の照度が本実施例より低いばかりでなく、ｄ＝２０ｍｍの場合に「中抜け」現象が見られた。

【００２２】図７は、平凸レンズ５０を使用しない請求項２の発明の光路図の１例を示すが、ロッドレンズ４０に入射した光が出射面に到達するまでは、請求項１の発明の光路図を示す図６と同じである。しかし、ロッドレ

ンズ４０の出射面の曲率半径Ｒ2 が入射面の曲率半径Ｒ１よりも小さいので、光は入射時より大きく屈折してロッドレンズ４０から出射し、設定された位置の光照射面に集光する。すなわち、ロッドレンズ４０が、ライトガイドＦの出射端Ｆｏｕの照度分布を被照射面に投影する投影レンズの働きをするので、平凸レンズ５０を使用したのと同じ効果があり、被照射面における照射領域の照度分布に「中抜け」が生じない。そして、平凸レンズ５０を使用しないので、部品点数を少なくでき、反射や吸収による光の損失が減るので照度が高くなる。

【００２３】

【発明の効果】以上説明したように、本発明は、ライトガイドから出射する光を、ロッドレンズ、またはロッドレンズと平凸または両凸レンズからなる投影光学系により被照射面に集光するので、被照射面までの距離が大きい場合にも、照度分布に「中抜け」現象が発生せず、照射領域中央部の放射照度を高くすることができる。また、従来、ライトガイドとレンズとの間、レンズとレンズとの間の空気層の占める割合が多く、その分レンズ径が大きくなっていたが、該空気層を屈折率の大きいロッドレンズと置き換えることにより、ロッドレンズおよび平凸または両凸レンズの径をライトガイドの径とほぼ同等にすることができる。従って、ライトガイドの出射端に投影光学系を設けたにもかかわらず光出射部の径は拡大しない。このため、被照射物であるワークとその搬入機構などとのクリアランスが小さい場合にも、光出射部をワークに接近させることが可能になる。また、出射部からワークまでの距離が大きくなっても「中抜け」のな＊

＊い光を照射することができる。従って、出射端から被照射面までの距離の長短にかかわらず、照射条件の調整を容易に行うことができ、ワークの材質や種類が変化しても、その照射条件に対して自在に対応できる。

【図面の簡単な説明】

【図１】光照射装置の説明図である。

【図２】照度分布の「中抜け」の説明図である。

【図３】光出射部の従来例の説明図である。

【図４】請求項１の発明の光出射部の断面図である。

【図５】請求項２の発明の光出射部の断面図である。

【図６】請求項１の発明の光路図である。

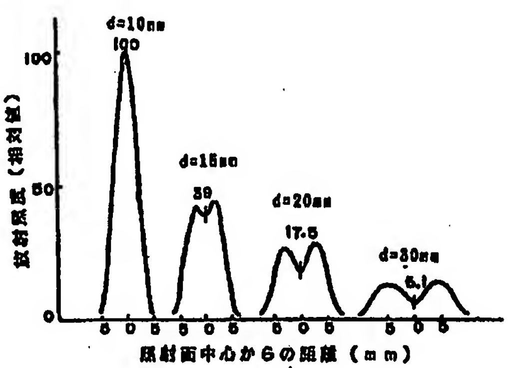
【図７】請求項２の発明の光路図である。

【図８】放射照度分布曲線図である。

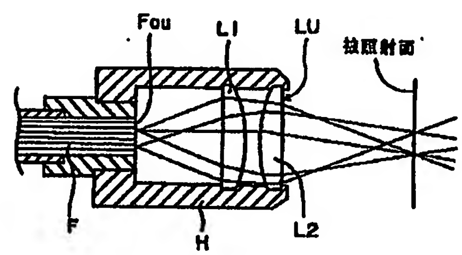
【符号の説明】

１０　放電ランプ
１１　陰極
１２　陽極
２０　ミラー
３０　保持部材
４０　ロッドレンズ
５０　平凸レンズ
Ｆ　ライトガイド
Ｆｉｎ　ライトガイドの入射端
Ｆｏｕ　ライトガイドの出射端
ＦＪ　接合部
Ｈ　ホルダー
Ｓｔ　シャッター

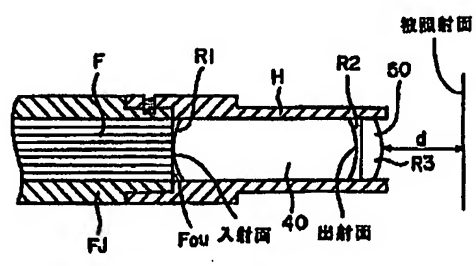
【図２】



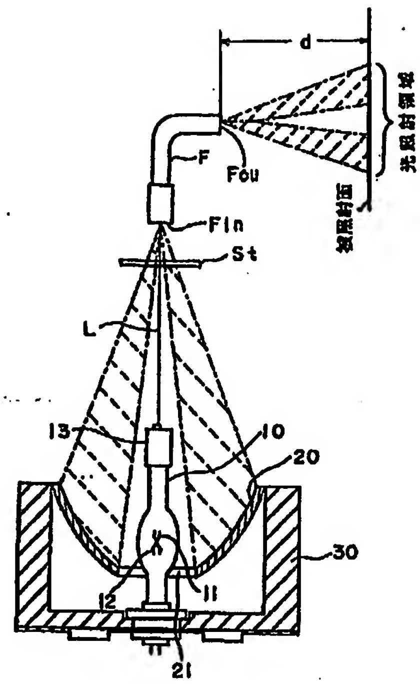
【図３】



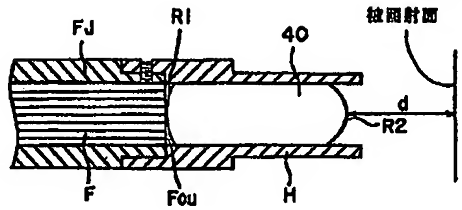
【図４】



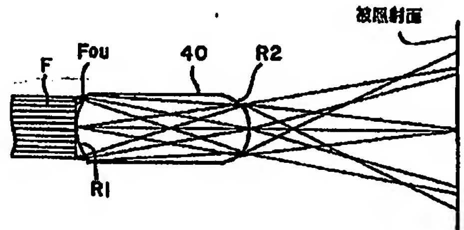
【図1】


d
F
Fou
Fin
St
L
13
10
20
30
12
11
21
被照射面

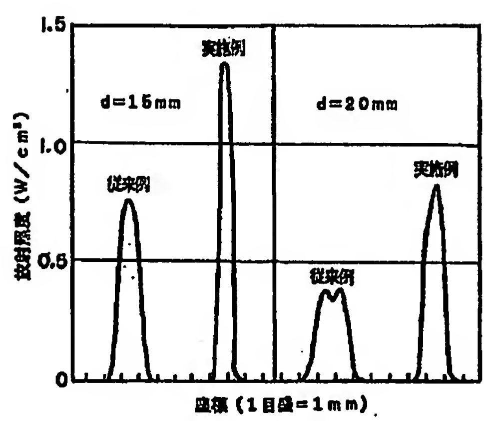
【図5】


FJ
R1
40
被照射面
d
R2
F
Fou
H

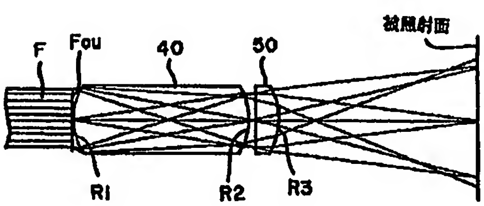
【図7】


被照射面
F
Fou
40
R2
R1

【図8】


d=15mm
d=20mm
実施例
従来例
実施例
従来例
1.5
1.0
0.5
0
放射照度（W/cm²）
座標（1目盛=1mm）

【図6】


F
Fou
40
50
被照射面
R1
R2
R3